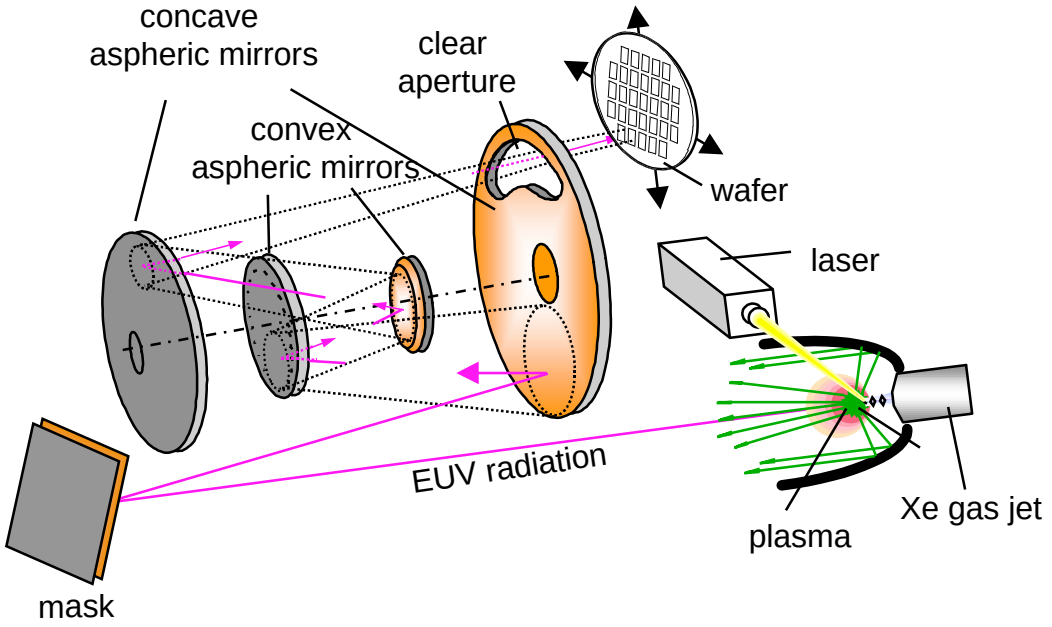
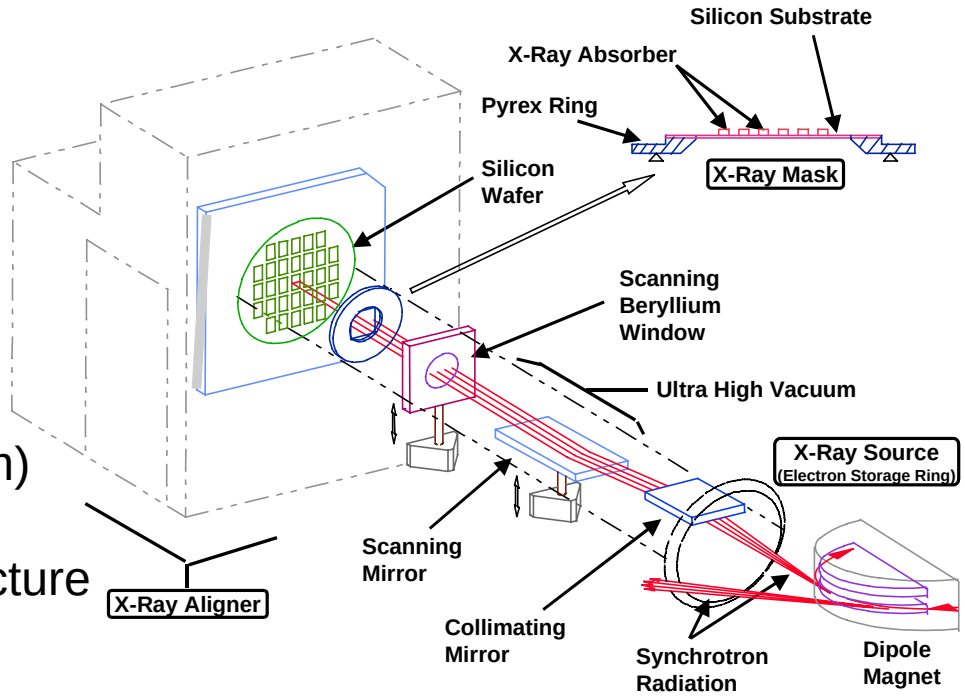
Extreme Ultraviolet Lithography: EUV

- **Principal**
  - 4X all reflecting mirror scanning projection
  - λ = 13.4 – 13.5nm (Mo-Si)
  - N.A. = 0.1 - 0.25 (limit 0.55)
- **Prospects**
  - 70nm to ~>35 nm nodes
  - 40 to 80 wph (300mm)
    - depending on source
- **Problems**
  - Defect free reflection masks
    - repair method issues
  - Source: power, lifetime (debris)
    - 400W laser MoSi coatings – LPP,DPF,CD,etc.1500W laser & MoSi coatings
  - Production resists (modified DUV chemistries)
    - < 5 mJ/cm^2 sensitivity w/ good LER
  - Mirror quality & optics design (# of mirrors, non-telecentric)
- **Multiple Development efforts**
  - North America - "EUV-LLC" (Intel, Motorola, AMD, Micron, IFX, IBM, National Labs, multiple suppliers), ISMT, others
  - Europe – EUCLIDIES, LETI, ASML, Zeiss, IFX, Phillips, others
  - Asia - ASET EUVL (NTT, Atsugi Research Center, Subaru), Nikon, Canon, others



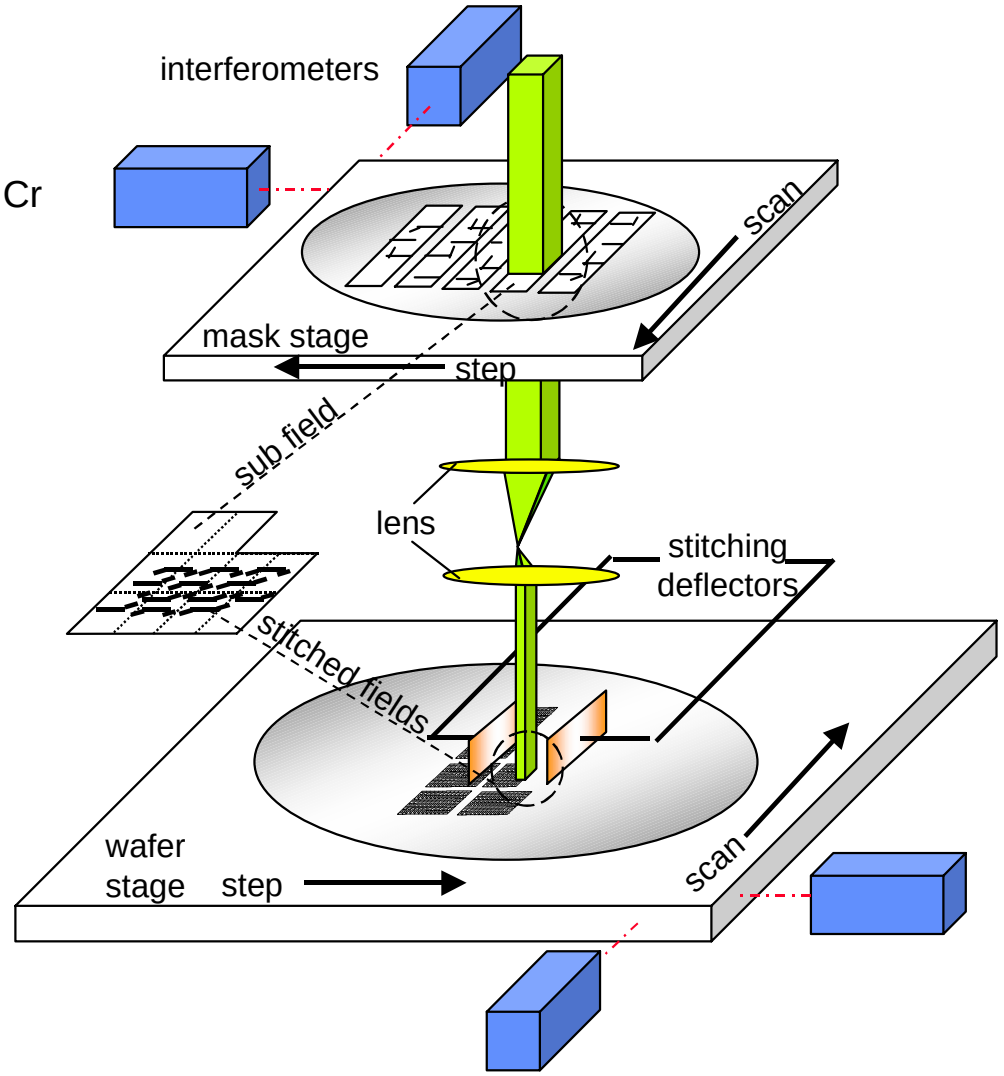
1X X-Ray Proximity Lithography

- **Principal**
  - 1X scanning proximity
    - synchrotron source
    - point source
  - 1X membrane mask
- **Prospects**
  - 100nm to 50 nm nodes
  - Common DUV resists
  - Large fields (50mm x 50mm)
    - multiple die / fields
  - Most mature NGL infrastructure
- **Problems**
  - 1X mask requirements
    - 100nm CD writer
    - defect density @ 1X
    - large membrane instabilities
  - production gap requirements
    - < 10 µm gap for 75nm exposures
  - source logistics (synchrotron)
- **Multiple development efforts**
  - North American (MIT, Lockheed Sanders, SAL)
  - Asia - ASET, Mitsubishi, Selete, Canon, etc.



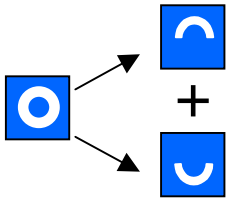
Electron Projection Lithography: (EPL)

- **Principal**
  - 4X e-beam projection
  - Sub field mask (stitching)
    - Scalpel scatter W – Cr or TaSiN – Cr
    - PreVail stencil (SiO_2 – Cr)
  - Low N.A. = 1 – 3 mrad (~0.001)
- **Prospects**
  - 100nm to 50nm nodes
  - Large DOF
  - reticle cost = optical ?
    - linear printing, no OPC needed
    - MEEF = ~ 1.0
- **Problems**
  - Throughput
    - ~30 wph @ 100 - 70nm (300mm)
    - ~23 wph @ 50nm (300mm)
    - beam blur & space charge
  - Wafer heating
    - energy on wafer = ~ 1000 mJ/cm^2
    - local temp. rises ~ 5 to 10^o C
    - distortion control
- **Multiple development efforts**
  - PreVail - Nikon & IBM ***– current efforts***
  - Scalpel "eLith" AMAT, ASML, Lucent, TI, etc – ***disbanded efforts***



Ion Projection Lithography : (IPL)

- **Principal**
  - 4X ion beam (H+, He+) projection
  - using stencil mask (complimentary)
  - Very low N.A. = ~0.0005
- **Prospects**
  - 70nm to ≤50nm nodes
  - higher throughput vs. EPL
    - 35 wph best case @ 70nm
    - 28 wph @ 50nm (300mm)
  - Large DOF (~10mm)
- **Problems**
  - Stencil masks
    - complementary masks
    - mask butting / overlay



  - Limited to one tone resist strategy
- **Development efforts**
  - MEDEA - Infineon, IMS (Vienna, Stuttgart)